# SECTION 3

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# 3. CUSTOMER/NASA RESPONSIBILITIES

## *3.1 Customer Responsibilities*

Customer responsibilities in the development of a HH mission begin early in the flight system development phase and continue throughout the post-mission phase. The following subsections describe the customer responsibilities throughout the planning/development phase, pre-mission phase, mission operations phase, and post-mission phase. (See milestone schedule on page 3.29).

### 3.1.1 Customer Planning/Development Responsibilities

During the planning/development phase, the customer is responsible for the activities described in the following subsections.

#### 3.1.1.1 Programmatic Responsibilities

The customer must:

a. Conduct all pre-planning activities with the HH Project Office at the GSFC, Greenbelt, MD.

b. Prepare the HH CPR Document (Appendix E) for GSFC review and approval.

c. Designate what services they require.

#### 3.1.1.2 Mechanical Responsibilities

Prior to implementation, the customer must submit a structural integrity verification plan for approval by the HH Project Office. This plan addresses the specific manner in which the various design, analysis, and test requirements of this section will be satisfied, and defines which of the documents and reports listed in Table 3.1 will be delivered to the HH Project Office for review. The customer may request an exception to a specific requirement provided that sufficient technical rationale accompanies the request. The request should be presented as part of the plan; it will be evaluated concurrently.

Once the structural integrity verification plan has been implemented, the customer is responsible for providing a structural integrity verification report, which presents the results of all analysis and test activities described in the verification plan. The structural integrity verification report (due at L-13 months) is referenced in the Hazard Report section of the customer safety data submittal. This cross-referencing is used to document the completion of a particular hazard control verification activity.

TABLE 3.1 STRUCTURAL INTEGRITY VERIFICATION REPORT DELIVERABLES

| | |
|---|---|
| Miscellaneous: | Complete Parts and Materials List<br>Complete Payload Assembly and Interface Control Drawings |
| Analyses: | Detailed Stress Analysis<br>- including finite element model<br>Fracture Control Analysis<br>- including certification of Nondestructive Evaluation (NDE) inspections<br>Thermal Analysis<br>Pressure Profile Analysis |
| Test Reports: | Random Vibration Test<br>Structural/Strength Qualification Test<br>Modal Test<br>- modal survey, sine sweep, etc.<br>Acoustic Test<br>Mass Properties Measurements<br>Thermal Test<br><br>Other Payload-Specific Tests<br>to meet requirements |

The customer may be exempted from a specific requirement by the HH Project Office. Only the applicable analyses and tests from the above list should be included as deliverables in the structural integrity verification plan and report.

*3.1.1.2.1 Standards*

The customer is responsible for using design analysis, fabrication, inspection, assembly and testing practices consistent with commonly accepted aerospace industry standards and specific NASA requirements.

*3.1.1.2.2 Drawings*

The customer is responsible for providing the drawings and other information required for GSFC to produce the Mechanical Interface Control Drawings (MICD). These drawings will be controlled by GSFC; any proposed changes after initial release will require the approval of both parties. The type of mechanical interface control drawing information required is listed in Table 3.2.

The MICD is a vital document since it states the mutual customer-NASA understanding in all mechanical interface areas such as:

a. Hole location tolerances
b. Hole diameter tolerances
c. Interface plane flatness
d. Interface plane finish
e. Interface thickness

In addition, two sets of final detail fabrication and assembly drawings shall be provided upon request to the GSFC for review and reference. If the customer submits a 3-D CAD model, GSFC will incorporate it into the integrated payload autocad model used for illustrations and studies of access and field of view requirements.

*3.1.1.2.3 Exposed Corners, Edges, and Protrusions*

Customer hardware shall be designed to minimize the likelihood of personal injury from contact with sharp corners, edges, protrusions, or recesses. In general, this means rounding exposed edges and corners to a minimum radius of 0.03 inches. Edges and corners that present a safety hazard or may be potentially damaging to other equipment during usage shall be suitably protected or rounded to a minimum radius of 1/2 inch. Protrusions, which for operational reasons cannot be made safe, shall be covered with a protective device.

*3.1.1.2.4 Mass Properties*

The weight, center of gravity, moments and products of inertia (about the component cg) of each component shall be provided in the CPR document. The basis for these numbers shall also be provided (i.e., estimated, calculated from fabrication drawings, or actually measured). The customer shall clearly state what contingency, if any, exists. The final experiment weight must be actually measured for incorporation into the overall HH payload finite element model. Mass properties shall be reported using the following units: inches, pounds, and slug-ft2.

TABLE 3.2 MECHANICAL INTERFACE CONTROL DRAWING REQUIRED INFORMATION

a. Compnent Dimensions

b. Envelopes
   * Static
   * Thermal
   * Dynamic

c. Coordinate System
   * Origin
   * Orientation

d. Mass Properties
   * Weight, C.G.
   * Basis (% Est, Cal, Act)
   * Inertias

e. Attachment Details
   * Number, Locations
   * Reaction Directions

f. Instrument Field of View
   * Origin
   * Size
   * Shape

g. Radiator Field of View
   * Origin
   * Size
   * Shape

g. Electrical Connectors
   * Location
   * Type
   * Identification

i. Electrical Grounding Detail

j. Fluid Service
   * Type Frequency
   * Location
   * Details

k. Radioactive Sources
   * Strength
   * Location
   * Type

l. Ground Handling Points
   * Location
   * Details
   * MRDPS
   * Orientation

m. Optical Alignment Details

n. Access Areas
   * Identification
   * Location
   * Size

o. Doors and Appendages
   * Location
   * Size
   * Mass
   * Duty Cycle

p. Remove/Install Pre/Post Item Locations
   * Size
   * Function

q. Ordnance/Actuator Details
   * Location
   * Type
   * Function

r. Notes
   * Safety Precautions
   * Special Provisions
   * Test Configurations
   * Shipping/Storage
   * Cleanliness
   * Materials

### 3.1.1.3 Design Requirements

*3.1.1.3.1 Equipment Integrity and Factors of Safety*

All customer equipment shall be designed to withstand the launch, operational, reentry, and landing environments of the Shuttle without failures, leaking hazardous fluids, or releasing equipment and loose debris or particles that could damage the Space Shuttle or cause injury to the crew. The customer equipment shall be subjected to structural testing at 1.25 times the limit loads and show positive margins of safety by analysis at 1.4 times the limit load for all ultimate failure modes such as material fracture or buckling. Alternatively the customer may qualify the equipment by analysis alone by showing positive margins of safety at 2.0 times the limit loads for material yield and 2.6 times the limit loads for ultimate failure modes. This technique is pending JSC approval on a case-by-case basis. Complex structural interfaces or elements may be required to undergo structural testing. Customers choosing to perform structural verification by analysis should review their qualification plans with GSFC early in their program for approval. Pressure vessels, lines, fittings, and sealed containers shall be designed in accordance with NSTS 1700.7.

*3.1.1.3.2 Limit Acceleration Load Factors*

Table 3.3 shows generalized design limit load factors for HH payload/instrument structures. These loads envelope the worst case steady state, low frequency transient, and higher frequency vibroacoustic launch and landing load environment. Refined design loads may be supplied when the payload/carrier configuration has been established. Final flight limit loads will be derived from the Shuttle Coupled Flight Loads Analysis performed for the Space Shuttle mission the customer is manifested on. Smaller, nonstructural components and assemblies should be designed using load factors that account for the transmissibility between the payloads primary structure and the component or assembly. When the transmissibility cannot be measured or estimated adequately the loads given in Table 3.3 shall be used. Use of loads other than those in Table 3.3 for safety critical components/assemblies requires HH program approval.

The load factors are in g's and rad/sec$^2$. All loads should be considered as positive and negative, simultaneous, and in all possible combinations. All accelerations should be applied through the payload's center of mass using the Shuttle coordinate system. Any thermally induced loading shall be combined with the above loads. On orbit thermal loading must also be considered.

GSE must be designed using a factor of safety of 5.0 for ultimate failure.

*3.1.1.3.3 Vibration Frequency Constraints*

All customer-supplied equipment shall have a lowest natural frequency of 35 Hz or greater when mounted to GSFC hardware. It is desirable to have the lowest natural frequency above 50 Hz. The frequency should be assessed at the HH-to-customer interface. It is recommended that customer primary structure be designed to meet the higher 50 Hz minimum frequency. Verification requirements increase significantly for payloads with a lower first fundamental structural frequency, see section 3.1.1.4.2. The customer is responsible for demonstrating satisfaction of this requirement.

TABLE 3.3 HITCHHIKER PAYLOAD/INSTRUMENT STRUCTURE DESIGN LIMIT LOAD FACTORS

| Load Factor, G | | | Angular Acceleration rad/sec$^2$ | | |
|---|---|---|---|---|---|
| NX | NY | NZ | Rx | Ry | Rz |
| +11.0 | +11.0 | +11.0 | +85 | +85 | +85 |

HITCHHIKER TERTIARY ASSEMBLY/COMPONENT
DESIGN LOAD FACTORS

| Weight lb | Load Factor, G |
|---|---|
| <20 | 40 |
| 20-50 | 31 |
| 50-100 | 22 |

Use the above load factors for components whose natural frequency is 40 Hz or less. Apply these factors in the most critical direction with 30% of the load factor applied in the remaining two directions.

*3.1.1.3.4 Acoustic Noise and Random Vibration*

All customer equipment shall be designed to withstand the vibroacoustic environment of the Shuttle without failure. If the customer chooses to perform an acoustic test, the levels given in Table 3.4 should be used. Payloads on the HHBA will normally be subjected to an acoustic test during integration. General Shuttle component random vibration test specifications are listed in Table 3.6 of the test requirements section 3.1.1.5.3.

*3.1.1.3.5 Materials*

Allowable mechanical properties of structural materials shall be obtained from MIL-HDBK-5D. Structural parts shall be made of materials with high resistance to stress corrosion cracking listed in Table I of the latest version of MSFC-SPEC-522. Use of other materials requires a Materials Usage Agreement (MUA). See Appendix B of this document. A list of materials shall be submitted to GSFC as soon as possible.

3.1.1.3.5.1 Non-Metallic Materials

Use of non-metallic material shall be restricted to those materials which have a maximum collectable volatile condensable material content of .1% or less and a total mass loss of 1.0% or less. NASA-GSFC will provide the customer a list of approved materials for use in the thermal/vacuum environment upon request.

*3.1.1.3.6 Thermal Blanket Attachment Requirements*

There are no formal requirements for structural attachment of thermal blankets. Specific attachment methods are determined on a case-by-case basis depending on payload design, possible contamination constraints, availability of attachment hardware, etc. Typically a combination of various methods is used to attach the blankets to the payload. One mechanical fastener is required as an attach point for thermal blanket grounding. Grounding of thermal blankets shall be in accordance with ICD-2-19001.

*3.1.1.3.7 Design Envelope*

In the design stage of the experiment, the customer must design the flight hardware to stay within the access envelope of the HH carrier hardware. For canisters, this envelope is shown in Figure 2.10. Experiments that are designed to mount to a HH pallet should not extend over the sides of the pallet. Experiments that do extend over the side of the pallet may interfere with ground support equipment used to lift or handle the pallets. Experiments that extend over the side may also interfere in the payload envelope of an adjacent experiment mounted nearby.

If during the design phase the design team realizes that an experiment overhang is unavoidable, the HH mission manager and the lead mechanical engineer for the payload should be contacted immediately to discuss possible workarounds.

### 3.1.1.4 Analysis Requirements

*3.1.1.4.1 Structural Analysis Requirements*

The customer is required to perform stress analysis in sufficient detail to show that the design FS described in paragraph 3.1.1.3.1 are met or exceeded and that MS of zero or greater can be shown for both yield and ultimate stress conditions, i.e.,

$$MS = \frac{\text{Allowable Stress}}{(\text{F.S.})(\text{Actual Stress})} - 1 \geq 0$$

Stress analysis shall use methods and assumptions consistent with standard aerospace practices. Buckling, crippling, and shear failures shall be considered ultimate failures. Allowable material stresses shall be taken from MIL-HDBK-5. When alignment of components is critical to performance, it is suggested that the material micro-yield allowable be used in lieu of the 0.2% offset yield allowable.

TABLE 3.4 RECOMMENDED ACOUSTIC LEVELS * HITCHHIKER PAYLOADS (01/90)

| One Third Octave Center Frequency (Hz) | Noise Level (dB) Protoflight | Re: .00002 Pa Acceptance |
|---|---|---|
| 25 | 122.0 | 119.0 |
| 32 | 125.0 | 122.0 |
| 40 | 128.0 | 125.0 |
| 50 | 130.5 | 127.5 |
| 63 | 131.5 | 128.5 |
| 80 | 132.0 | 129.0 |
| 100 | 132.0 | 129.0 |
| 125 | 132.0 | 129.0 |
| 160 | 131.5 | 128.5 |
| 200 | 130.5 | 127.5 |
| 250 | 130.0 | 127.0 |
| 315 | 129.0 | 126.0 |
| 400 | 128.0 | 125.0 |
| 500 | 127.0 | 124.0 |
| 630 | 126.0 | 123.0 |
| 800 | 124.5 | 121.5 |
| 1000 | 123.0 | 120.0 |
| 1250 | 121.5 | 118.5 |
| 1600 | 119.5 | 116.5 |
| 2000 | 118.5 | 115.5 |
| 2500 | 116.0 | 113.0 |
| 3150 | 114.5 | 111.5 |
| 4000 | 112.5 | 109.5 |
| 5000 | 111.0 | 108.0 |
| 6300 | 109.0 | 106.0 |
| 8000 | 107.5 | 104.5 |
| 10000 | 106.0 | 103.0 |
| **Overall** | **142** | **139** |

Test Duration 60 sec

* Assumes HH payload not in an annulus region

*3.1.1.4.2 Structural Modeling Requirements*

The customer is required to submit a test-verified finite element math model to GSFC for each customer-supplied payload or component which has demonstrated, or is expected to have, a lowest natural vibration frequency of less than 50 Hz when mounted to a rigid interface between the carrier and the component. All finite element models delivered to GSFC must demonstrate mathematical validity by showing that the model contains six rigid body frequencies of value .001 Hz or less. The math model should contain as few degrees of freedom as necessary for accurate simulation of frequencies and mode shapes under 50 Hz but in all cases must be limited to no more than 300 degrees of freedom. Specific details with regard to the form and content of a finite element math model that is to be submitted to GSFC will be agreed upon between the payload and GSFC on a case by case basis. A finite element math model is not required for components with lowest natural frequencies above 50 Hz, unless deemed necessary by GSFC.

Payloads having a lowest natural frequency greater than 50hz must, however, provide an analysis, either classical or finite element, that confirms the result of the testing described in 3.1.1.5.2. Test verification of math models can be achieved by performing a modal survey test on the payload.

*3.1.1.4.3 Fracture Control*

A fracture control program is required for all customer equipment mounted on plates or in canisters with opening lids. Since canisters without opening lids provide essential containment of all customer equipment, the requirements of fracture control are generally satisfied if the payload does not include any pressure vessel or other hazardous equipment. The customer is responsible for providing a Fracture Control Implementation Plan, which describes in detail how the requirements of the NASA-STD-5003 will be satisfied. The information that should be included in the implementation plan is described in section 4.1.3 of NASA-STD-5003. The fracture control program implemented by the customer shall provide assurance that no catastrophic hazards to the Shuttle Orbiter or crew will result from the initiation or propagation of flaws, cracks, or crack-like defects in customer structure during its mission lifetime, including fabrication, testing, and service life. In addition, all customer structural fasteners must comply with GSFC S-313-100 Fastener Integrity Requirements. The plan must be approved by GSFC prior to implementation. It will normally be included as part of the structural integrity verification plan described earlier.

*3.1.1.4.4 Pressure Profile*

Table 3.5 and Figures 3.1, 3.2, and 3.3 define the Orbiter cargo bay internal pressure history to be used by payloads for design and venting analyses. Orbiter cargo bay vent door opening occurs at altitudes between 70,000 and 94,000 feet. The repressurization rate of the cargo bay will not exceed 0.3 psi/sec during descent.

The pressure profiles given pertain to plate-mounted equipment. The pressure profiles for canister-mounted hardware may be different depending on the configuration.

## 3.1.1.5 Test Requirements

*3.1.1.5.1 Structural Test Requirements (Qualification by test)*

The customer is required (for exceptions see paragraph 3.1.1.3.1) to perform strength testing of all components sufficient to demonstrate that no detrimental permanent deformation or ultimate failures occur when loads are imposed on the structure such that every primary load carrying member experiences a stress equal to a minimum of 1.25 times the limit stress. The limit stress is the highest stress produced by any one of the combinations either design limit acceleration load factors in paragraph 3.1.1.3.2 or the refined loads supplied by HH project. To satisfy this requirement, it is not necessary to impose the precise externally applied load factors in a single test. The imposed load may be artificial and may be imposed in a number of different load cases, each one of which produces the required stresses in only a portion of the structure, as long as the net result is the required stresses in all primary load-carrying members. The test load may be applied by pulling on the structure with discrete forces, by the application of a linear acceleration field (centrifuge) or by subjecting the instrument to a below-resonant frequency sine dwell or sine burst vibration test.

*3.1.1.5.2 Natural Frequency Verification Test*

All customer-supplied equipment shall have its lowest cantilevered natural frequency verified by test if the predicted natural frequency is below 100 Hz. Acceptable tests for verifying natural frequencies include modal survey and sine sweep vibration. Large payloads with natural frequencies less than 50 Hz may be required to undergo modal survey testing to recover both structural mode frequencies and mode shapes.

TABLE 3.5 ASCENT CARGO BAY PRESSURE AND DECAY RATE ATTACHMENT 1 (ICD 2-19001) CHANGE

| Time | Maximum Cargo Bay Pressure | Minimum Cargo Bay Pressure | Maximum Rate of Depressurization |
|---|---|---|---|
| 10 | 14.45 | 14.20 | 0.155 |
| 20 | 13.20 | 12.50 | 0.255 |
| 30 | 11.25 | 10.00 | 0.360 |
| 35 | 10.05 | 8.90 | 0.510 |
| 38 | 9.40 | 8.20 | 0.735 |
| 39 | 9.15 | 7.60 | 0.760 |
| 40 | 8.95 | 7.20 | 0.760 |
| 41 | 8.70 | 6.80 | 0.760 |
| 45 | 7.75 | 5.70 | 0.640 |
| 48 | 7.20 | 5.10 | 0.570 |
| 49 | 7.05 | 4.90 | 0.575 |
| 50 | 6.90 | 4.70 | 0.550 |
| 51 | 6.60 | 4.50 | 0.520 |
| 52 | 6.10 | 4.30 | 0.455 |
| 55 | 5.35 | 3.65 | 0.355 |
| 60 | 4.30 | 2.70 | 0.273 |
| 65 | 3.50 | 2.00 | 0.225 |
| 70 | 2.70 | 1.40 | 0.195 |
| 80 | 1.30 | 0.60 | 0.150 |
| 90 | 0.60 | 0.20 | 0.115 |
| 100 | 0.25 | 0.10 | 0.075 |

Note:
a. Pressure in psia
b. Rate of depressurization in psi/second
c. Time in seconds from lift-off

*3.1.1.5.3 Random Vibration*

All customer flight equipment must be tested in order to qualify it for the Shuttle vibroacoustic environment. Table 3.6 below is a generalized vibration specification for Shuttle equipment. In some cases a more refined specification will be supplied once the payload/carrier configuration has been established. The HH project may waive this requirement in some instances such as reflown or contained hardware. New designs must be tested to qualification levels. Series or reflown hardware may be tested to acceptance levels. A protoflight unit may be used for qualification testing.

TABLE 3.6 GENERALIZED SHUTTLE COMPONENT RANDOM VIBRATION (50 LBS. OR LESS)

| Frequency (Hz) | ASD Level ($G^2$/Hz) | |
|---|---|---|
| | Qualification | Acceptance |
| 20 | .025 | .0125 |
| 20-50 | +6 dB/oct | +6 dB/oct |
| 50-600 | .15 | .075 |
| 600-2000 | -4.5 dB/oct | -4.5 dB/oct |
| 2000 | .025 | .0125 |
| Overall | 12.9 $G_{rms}$ | 9.1 $G_{rms}$ |

**The test may be modified and the acceleration spectral density level reduced for components weighing more than 50 pounds by using the following formula:**

dB reduction = 10LOG(W/50)

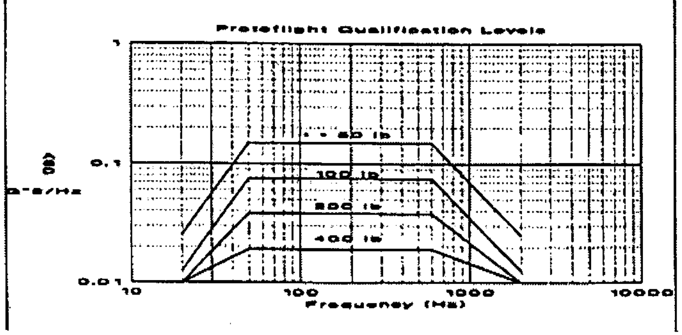
$ASD_{(50\text{-}600Hz)}$ = .15•(50/W) for protoflight

$ASD_{(50\text{-}600\ Hz)}$ = .075•(50/W) for acceptance

Where W = component weight

The slopes shall be maintained at +6 and -4.5 dB/oct for components weighing up to 125 pounds. Above this weight, the slopes shall be adjusted to maintain an ASD level of 0.01 $G^2$/Hz at 20 and 2000 Hz.

For components weighing over 400 pounds, the test specification shall be maintained at the level for 400 pounds.




Vibration test duration is one minute in each of the three orthogonal axes.

*3.1.1.5.4 Typical Test Sequence*

The above test requirements can often be satisfied by a single visit to a vibration test facility depending on the mass and stiffness of the payload. A typical test of this type would include:

1. A sine sweep test to verify the natural frequency,
2. A sine burst test to perform strength testing, and
3. A random vibration to qualify the payload for vibroacoustic environment.

This test sequence would typically be repeated in each axis. It must be remembered, however, that the sine burst applies a force field in a single axis whereas the design load factors occur in all three axes simultaneously.

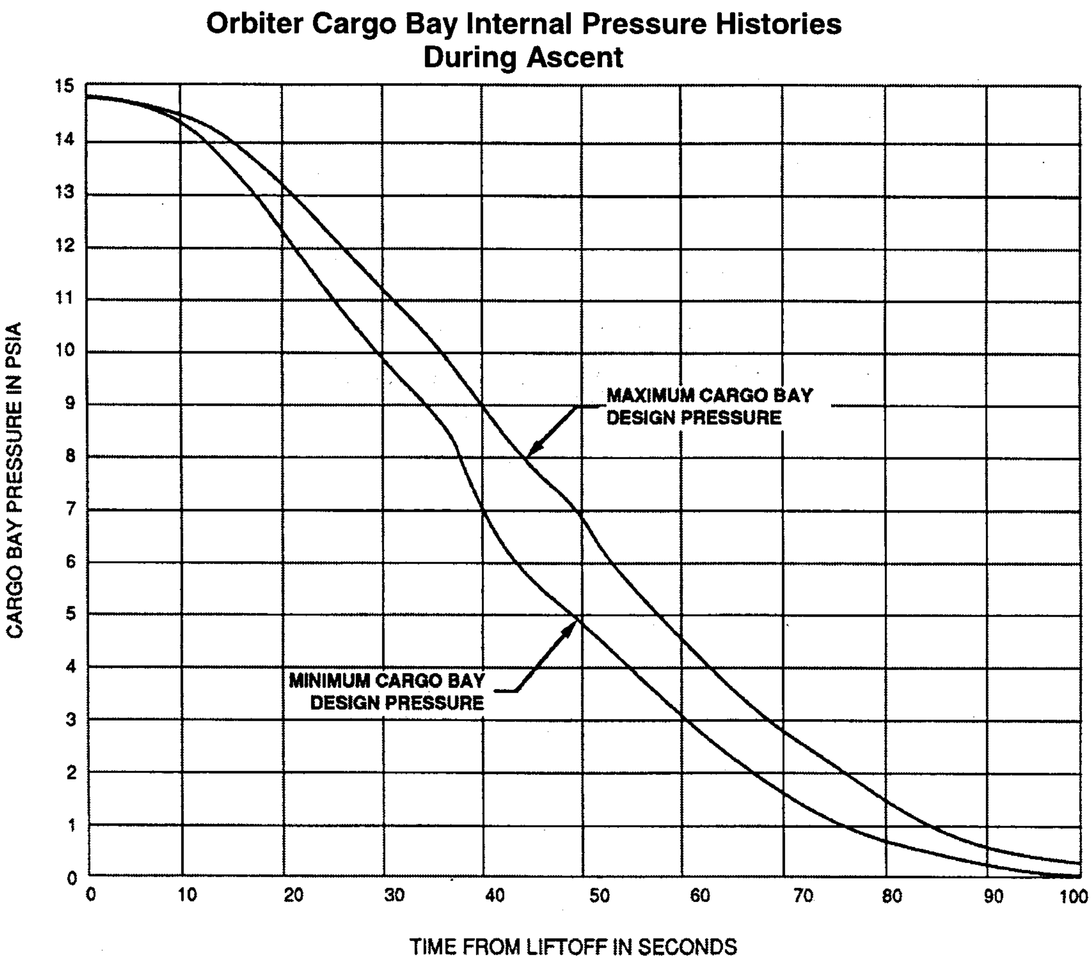



FIGURE 3.1 ORBITER CARGO BAY INTERNAL PRESSURE HISTORIES DURING ASCENT

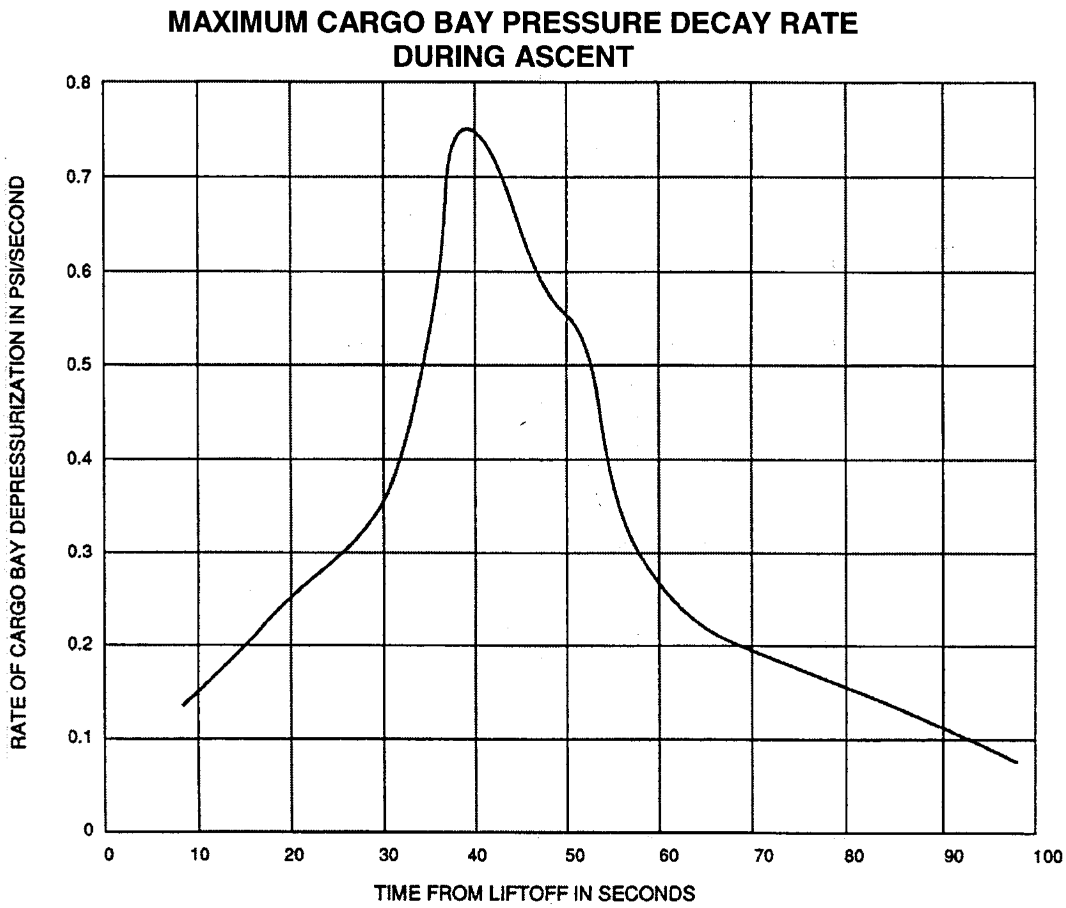
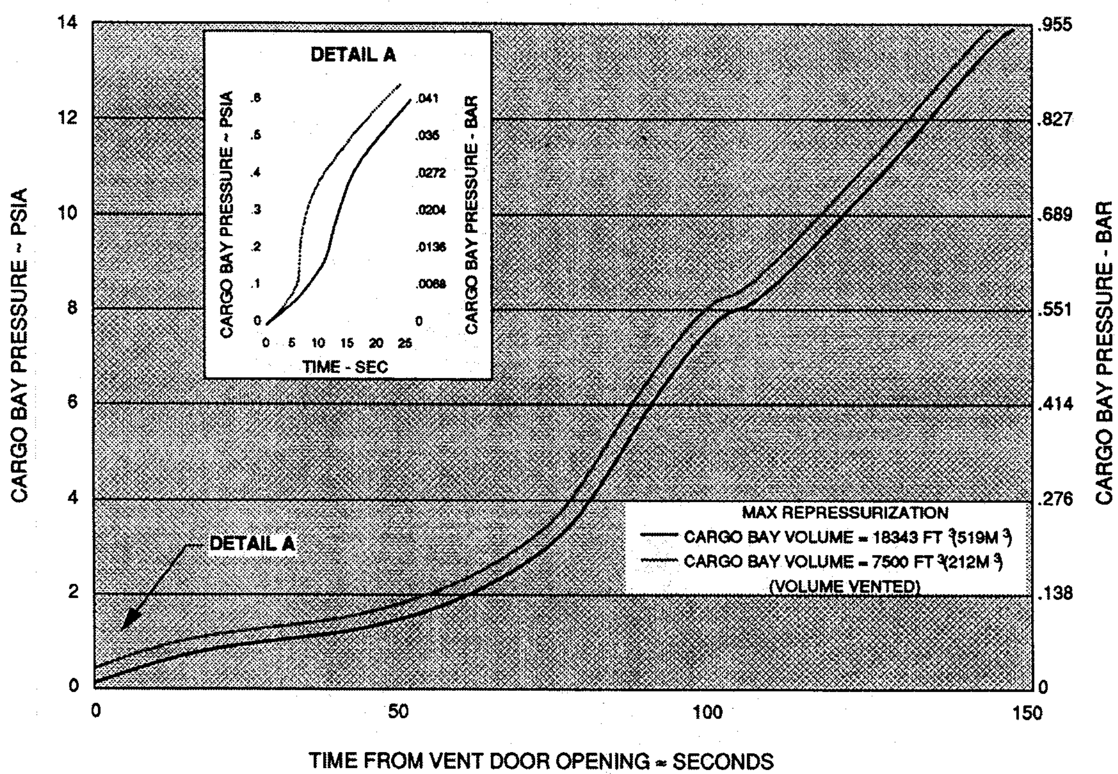



FIGURE 3.2 MAXIMUM CARGO BAY PRESSURE DECAY RATE DURING ASCENT

**MAXIMUM CARGO BAY ENTRY REPRESSURIZATION RATE**




(NASA /JSC PSEUDO TRAJECTORY, MAXIMUM
DYNAMIC PRESSURE (375/450) ~ PSF)

**ENTRY PHASE CARGO BAY INTERNAL PRESSURE VALUES,
TO BE USED FOR PAYLOAD DESIGN**

FIGURE 3.3 MAXIUM CARGO BAY ENTRY REPRESSURIZATION RATE

### 3.1.1.6 Compliance Requirements Summary

The following Table 3.7 is a general summary of mechanical compliance requirements. This matrix is not intended to be an exhaustive list, but rather to be used as a customer guideline. All payload-specific tests and analyses required will be determined in conjunction with the NASA GSFC SSP project office.

### 3.1.1.7 Electrical Responsibilities

a. Certify that the requirements presented in ICD-2-19001, Section 7.3 and 10.7, pertaining to EMI/EMC control have been met. Payloads will be subjected to high levels of radiation from the Orbiter transmitter and must not interfere with the Orbiter or other payloads. Experiments will also undergo conducted and radiated susceptibility tests and transient tests, per Reference #8 in Appendix I. Payloads are required to meet EMI/EMC testing requirements, and it is strongly recommended to perform EMI/EMC testing prior to delivery to GSFC.

b. Interfacing Circuits Schematic.

c. Power Distribution Schematic showing compliance with requirements of TA-92-038 for fusing and wire size.

### 3.1.1.8 Thermal Responsibilities

The customer must provide required thermal analysis, design data, descriptions of all surface coatings and insulation, and a reduced thermal math model of the payload; the reduced model should have approximately 20 nodes. The customer design is to provide heaters, thermostats, blankets, and coatings to maintain the payload temperature within the required range.

### 3.1.1.9 Materials and Safety Responsibilities

a. Submit a list of all materials (see Appendix B) used in the payload design to confirm the absence of hazardous agents or materials with poor structure, outgassing, and contamination characteristics. All fasteners should be in compliance with GSFC S-313-100.

b. Certify that the requirements of NSTS 1700.7B have been satisfied. Control of any items of a hazardous nature must be demonstrated, documented, and reviewed (pressure vessels, explosive devices, radioactive sources, exposed high temperature or high voltage, electromagnetic radiation, moving parts, any other personnel or equipment hazard.

Hitchhiker Test and Analysis Compliance Matrix

Please note that this matrix is a general summary of compliance requirements. This is not an exhaustive list. Use only as a guideline. All payload-specific tests and analyses required will be determined in conjunction with NASA GSFC SSPPO.

| | Requirement/Ref | Requirement Description | Compliance Approach | Payload Element | Test Description | Required Levels | Documentation |
|---|---|---|---|---|---|---|---|
| 1 | Structural Verification Plan CARS 3.1.1.2 | Submit Structural Verification Plan to GSFC.<br><br>Structural Verification Plan should encompass all requirements listed in this table.<br>Structural Verification Report (Analyses and Test Reports) should be submitted as required in this table. | | | | | |
| 2 | Fracture Control Implementation Plan NASA-STD-5003 | Submit Fracture Control Implementation Plan to GSFC. See Requirement #8. | Analysis | | | NASA-STD-5003 (See 731-005-83) also a guideline | |
| 3 | Mass Properties CARS 3.1.1.2.4 | Determine Weight | Test | Payload | Weigh the Payload | | |
| | | Determine Center of Gravity | Analysis or Test* | Payload | | N/A | Test Report |
| | | Determine Moments of Inertia | Analysis or Test* | Payload | Spin Test | | Test Report |
| | | Determine Products of Inertia | Analysis or Test* | Payload | Spin Test | | Test Report |
| 4 | Structural Qualification CARS 3.1.1.3.1 | Show positive margins of safety by analysis. | Analysis | Flight Structure | Static Load Test: "Pull" on the element with a sustained static force that stimulates the specified acceleration load OR Sine Burst Test which applies a quasi-static acceleration load | ± 11 g's in all three axes plus 1.25 Test Factor (RSS Value of load applied to three axes).<br><br>If 24g load cannot be accomplished, contact GSFC SSPP Project Office | Detailed Stress Analysis |
| | | Use FSy= 1.25 and FSult =1.4 if verifying by test. | Test | Proto-flight Structure or ETU | | | |
| | | Use Fsy= 2.0 and FSult = 2.6 if verifying by analysis alone. | Analysis | | | | |
| | | Note: For pressure systems or heat pipes, different Safety Factors are required. See Requirement #9. | | | | | |
| | | Note: Test with Flight structure meets requirement #6 below | | | | | |
| 5 | Natural Frequency Verification (ACCEPTANCE) CARS 3.1.1.5.3 | Predict natural frequency by analysis. | Analysis | Fully Integrated Payload OR payload structure with mass dummies | | Sine Sweep in each axis from 10 to 200 Hz at 2-4 oct/min (1/4g and 1/2g input levels are customary) | Dynamic Analysis |
| | | If predicted natural frequency (Fn) is 100 Hz, no test is required. | Classical or FEM Analysis | | N/A | | Dynamic Analysis |
| | | If 100 Hz > Fn50 Hz, verify frequency by sine sweep test. | Classical or FEM Analysis, and Test | | Sine Sweep or Modal Survey | | Analysis and Test Report |
| | | If 50 Hz < Fn 35 Hz, a modal survey may be required. | FEM Analysis Test | | Modal Survey | | Analysis and Test Report |
| | | Note: Payload may be required to submit a Model Verification Plan | | | | | |

*Test Required for Satellites

TABLE 3.7 HITCHHIKER TEST AND ANALYSIS COMPLIANCE MATRIX

| | Requirement/Ref | Requirement Description | Compliance Approach | Payload Element | Test Description | Required Levels | Documentation |
|---|---|---|---|---|---|---|---|
| 6 | Random Vibration | Qualify all experiment flight equipment for the STS vibroacoustic environment. | | | Random Vibration Test: Characterize the dynamic response of the experiment under expected flight random vibration levels. | | |
| | Qualification AND | Qualification Test on Engineering Test Unit AND | Test | Engineering Test Unit | | Random Vibration at flight + 3dB Loads for 60 sec per axis (See Table 3.6) | Test Report |
| | Acceptance | Acceptance Test on Flight Unit | Test | Fully Integrated Payload | | Random Vibration at flight loads for 60 sec per axis (See Table 3.6) | Test Report |
| | OR Qualification Only | Qualification Test on Flight Unit | Test | Fully Integrated Payload | | Random Vibration at flight + 3dB Loads for 60 sec per axis (See Table 3.6) | Test Report |
| 7 | Composite Materials / Bonded Joints (ACCEPTANCE) NSTS 14046 Section 5.1.1.1 (b) 731-0005-83B Section 7.2.10 | Acceptance test all Fracture Critical load-carrying composite structure at 1.25 x limit loads; MUST be on flight H/W; Component level preferred but assembly level OK. | Test | Flight Structural Components or Flight Structural Assembly | Static Load Test OR Sine Burst Test : This Requirement Is Met By Meeting Requirement #4 (Test Option) Above With Flight Hardware | ± 11 g's in all three axes plus 1.25 Test Factor (RSS Value of approximately 24g load applied to three axes) | Pull Test Fixture OR Vibration Table |
| 8 | Fracture Control 731-0005-83 | Submit Fracture Analysis Report to GSFC. | Analysis and/or Inspection | | NDE as required | NASA-STD-5003 (See 731-0005-83) also as a guideline | Fracture Control Analysis Report |
| | | Classify components in on of the following categories:<br>-Fail Safe<br>-Safe Life -<br>Contained -<br>Low Release Mass -<br>Low Risk | Fracture Classification | | | | |
| 9 | Pressure System<br>-Pressure vessels<br>-Dewars<br>-Lines, fittings, and components NSTS 1700.7 | See NSTS 1700.7 for requirements for each type of pressure system | Analysis to determine MDP | | | | |
| 10 | Acoustic | At discretion of GSFC, test may be required depending on configuration, see GEVS levels | | | | | |

| | Requirement/Ref | Requirement Description | Compliance Approach | Payload Element | Test Description | Required Levels | Documentation |
|---|---|---|---|---|---|---|---|
| 11 | Shock | Applicable for ejectables and deployables. Assess to determine if system shock is hazardous to payload. Use Figure 3.4 as an example of system shock. See SSPP Project Office for further information. | | | | | |
| 12 | Materials<br>-Fastener Integrity<br>S-313-100<br>-Stress Corrosion Cracking<br>MSFC-SPEC-522 | See Document for Test Requirements | Use Table 1 Materials | | | | Test Reports and Material Certifications as required |

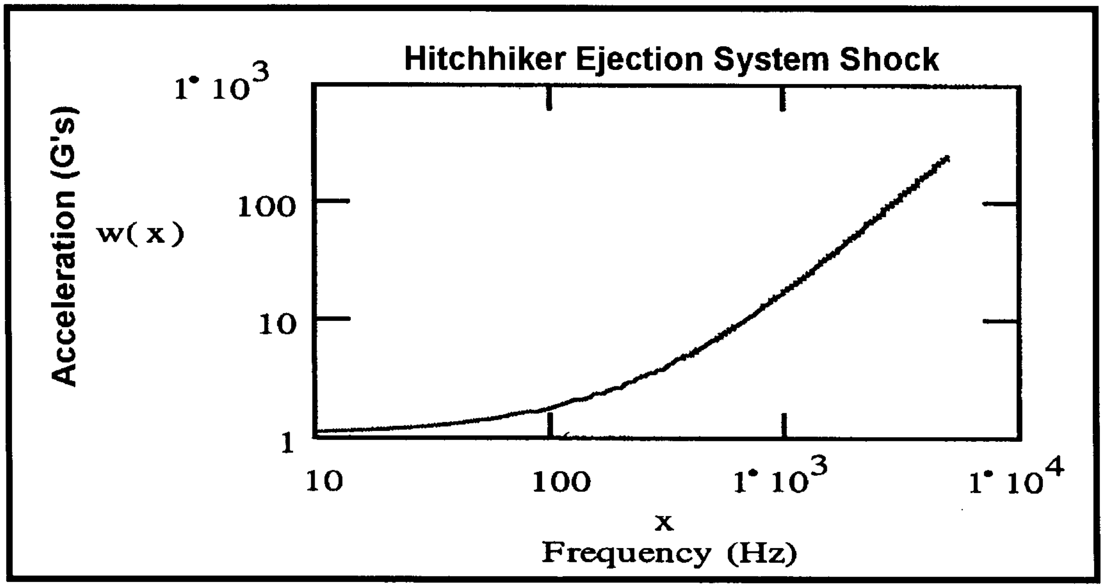



FIGURE 3.4 HICHHIKER EJECTION SYSTEM SHOCK

### 3.1.2 Customer Pre-Mission Responsibilities

The customer is required to meet the following responsibilities during the Pre-Mission Phase. All items to be delivered no later than hardware delivery to GSFC.

a. Provide all required testing procedures and documentation to demonstrate compliance with the Space Shuttle safety requirements as described in this document (Appendix A and elsewhere). Confirm proper operation of the customer thermal, mechanical, and electrical systems. Provide documentation and analysis of such tests already conducted by the customer.

b. Provide all necessary thermal coatings, blankets, inter-element cables, plus handling and shipping equipment.

c. Provide electrical ground support equipment for generating commands and providing necessary real-time data displays. This requirement is waived if the customer has minimal command/data requirements.

d. Provide all operational plans, procedures, equipment, and personnel for operating the customer payload and supporting GSFC test and operations staff during pre-flight testing and simulations.

e. Provide transportation as required of all customer equipment to GSFC.

f. Provide personnel support to NASA at the location designated to integrate the customer equipment to the Orbiter.

g. Provide support to NASA in systems testing to confirm proper operation of the integrated payload and the absence of interference between customer payloads.

h. Provide all Mechanical Ground Support Equipment (MGSE) required to ship flight and non-flight hardware to GSFC, KSC, or other locations for HH integration. Shipping containers and packaging materials must must comply with KHB 1700.7.

i. Provide personnel to support a mechanical receiving inspection and verification that all customer provided flight hardware conforms to the specifications agreed upon in the mission unique Mechanical Interface Control Drawing (MICD).

j. Provide all MGSE, personnel and procedures written in the format specified by KHB 1700.7 latest revision, required to handle flight equipment for mechanical integration to the HH system. Customer supplied MGSE, lift slings and fixtures, shall be proof loaded prior to use to a minimum of 2.0 times the rated working load. Written, dated, and signed test reports shall be provided, and if a hazard is identified, the condition shall be corrected prior to further use. These reports shall be supplied to the HH Project for approval. Following the load test, all ground handling equipment shall have a tag permanently affixed identifying the equipment, stating the rated capacity, the next scheduled load test due date, and a quality control indication assuring that the above information is correct. After this certification the MGSE shall not be disassembled or used for any other purpose.

k. Provide all necessary plans, personnel, and equipment required to support payload servicing and closeout operations at the Orbiter Processing Facility (OPF) and the pad if required.

l. Provide all requirements for space, power and air conditioning for the CGSE as well as electrical interface requirements.

### 3.1.3 Mission Operations Responsibilities

The customer is responsible for providing all operations plans, procedures, and personnel for operating the customer payload and ground support equipment as well as supporting the GSFC operations staff during all mission activities.

### 3.1.4 Post-Mission Responsibilities

The customer is responsible for providing planning, material, and personnel support to NASA at the locations designated to "safe" the payload, remove the customer equipment from the Orbiter, and, subsequently, deintegrate from the HH system.

## *3.2 HH And/Or Space Shuttle Organizational Responsibilities*

The joint responsibilities of the HH Project and the JSC Space Shuttle Program Office (SSPO), and those that are solely of the Shuttle, are described as follows. These responsibilities roughly parallel the mission development from planning to post-mission operations. NASA will:

a. Provide services and interfaces as agreed in the approved CPR document.

b. Provide standard HH carrier and ground equipment as defined in this document including flight interface cables and customer interface connectors (customer to carrier). (The customer will provide unique box-to-box cables.)

c. Provide integration (with customer support) of the customer equipment to the HH carrier.

d. Develop all necessary integrated documentation, plans, procedures, and software.

e. Conduct systems testing (with customer support) to confirm proper operation of all integrated payloads and the absence of interference between customers.

f. Conduct EMC testing of the integrated payload to confirm compliance with the Shuttle EMC requirements. Conduct post-ship functional testing at KSC prior to orbiter integration.

g. Perform integration of the payload into the Orbiter; provide launch, flight, re-entry, and landing of the Orbiter; remove the payload after the mission.

h. Provide mission compatibility analysis to determine the compatibility of customer requirements with the Shuttle and HH capabilities and with the other customer payloads and non-HH mixed cargo payloads on the same mission.
i. Provide mission management to control and decide multi-payload issues such as safety-related issues and the resolution of conflicts for mission resources between payloads.
j. Provide computer-compatible tapes of the customer low-rate data and standard orbit, attitude, and ancillary data for test purposes and for flight-acquired data.
k. Provide computer compatible tapes of customer medium-rate data and standard orbit, attitude, and ancillary data for test purposes and for flight-acquired data. See Appendix C for details of data products formats.

## 3.3 GSFC Responsibilities

The HH Project Office at the GSFC is solely responsible for the following activities in the development and operations of an HH mission. The office will:

a. Act as NASA's single point of contact for all customers participating in the HH Program.
b. Provide all integrated payload documentation.
c. Provide the customer with the outline for the HH CPR document and conduct review and approval of the document.
d. Provide the thermal fluxes and thermal descriptions of the areas near the customer payload. For canister customers, provide external insulation on the sides and bottom of canister if required. Provide thermal models, insulation, and heater system for plates.
e. Provide the customer with connectors that are to be used on the customer side of the electrical/signal interface.
f. Conduct tests on the integrated payload to confirm compliance with EMI requirements.
g. Provide customer facilities at GSFC as described in Appendix D. Some data services are optional extra cost services for reimbursable customers.

Note: As an optional service GSFC could perform customer anlyses and T&E.

## 3.4 Payload Requirements Documentation

As indicated in subsection 2.3, the customer is required to prepare a CPR document and present it to GSFC for approval. The HH Project Office will provide an outline of this document to the customer for use in the preparation of the document. The document will address the following areas:

a. Mechanical Interface Definition
b. Thermal Interface Definition
c. Electrical Systems Requirements
d. Operations Requirements
e. Flight Safety Data Package
f. Ground Safety Data Package
g. Ground Handling Requirements and Procedures
h. Materials List

## 3.5 HH Manifesting Scenario

A list of the steps that occur during the development of the customer's payload for flight as a HH mission follows:

a. The customer studies this Customer Accommodations and Requirements Specifications (CARS) document to determine if suitable accommodations are possible on HH carriers.

b. The customer prepares the CPR document (see outline in Appendix E) specifying desired accommodations and services and submits CPR to GSFC for review.

c. The customer consults with GSFC concerning acceptability of requirements.

d. The customer's organization submits Form 1628 -- Request for Flight Assignment (see Figures 1.1 and 1.1a) through the appropriate NASA Headquarters discipline office (see Table 3.8). Form 1628 requests accommodation on a HH-S or HH-C carrier and specifies the weight of the customer's equipment. Customer submits deposit if reimbursable.

TABLE 3.8 NASA HEADQUARTERS SECONDARY PAYLOAD DISCIPLINE OFFICES

| Discipline Office<br>NASA-Sponsored Payloads: | Office Code |
|---|---|
| Space Science | S |
| Shuttle Advanced Technology | MD |
| Space Technology | RS |
| Commercialization | CC |
| Space Station Technology | MS |

| Discipline Office<br>Reimbursable Payloads | Office Code |
|---|---|
| USA Domestic | CC1 |
| Foreign | XI1 |
| DOD | MC2 |

1) Reimbursable customers should contact Code MOB for pricing.
2) DOD Customers should contact USAF Space Systems Division USAF/SSD/CLP.

e. The customer discusses manifesting requirements with the discipline office official responsible for developing the discipline office secondary payload priority list and arranges to be included in the priority list at a satisfactory priority. These lists are updated periodically, so the customer needs to nsure that adverse changes in priority do not occur subsequent to the initial list.

f. The customer visits GSFC for a payload accommodation conference and detailed discussions of requirements and interfaces. GSFC approves requirements document.

g. The customer prepares and submits phase 0/1 safety data package.

h. JSC and GSFC, with customer support, perform phase 0/1 safety review.

i. GSFC and NASA Headquarters determine which customer payloads should be combined on a single HH carrier. HH-S customer equipment may be carried on a HH-M carrier if acceptable to customer and of benefit to NASA. GSFC prepares a summary payload description. GSFC and JSC begin preparation of the integrated payload documentation.

j. NASA Headquarters, JSC, GSFC, and the discipline offices assign the payload to a Space Shuttle flight based on the Summary Payload Description requirement.

k. Customer submits Phase 2 Safety Package. GSFC submits integrated payload Phase 2 Safety Packages including all customer data and applicable carrier data. JSC, KSC, GSFC, and the Customer perform payload Phase 2 flight and ground handling safety reviews.

l. Customer delivers flight hardware, Phase 3 safety data. GSFC performs customer equipment-to- carrier integration and testing. GSFC submits data for Phase 3 safety reviews. Phase 3 reviews conducted.

m. Payload is delivered to launch site, post-ship checks and servicing performed. Customer signs safety certificate.

n. Payload integrated into Orbiter, integration test performed, Shuttle is launched, flown, landed, deintegrated. Customer equipment returned to customer.

o. Customer data products sent to customer.

## *3.6 Integration And Test Overview*

### 3.6.1 Preintegration Testing

Months prior to delivery for flight, the customer may perform a preintegration test at GSFC using prototype or flight hardware in development. This test is offered to the customer as an early opportunity to verify the function of the interfaces between the experiment and the HH avionics, and between the CGSE and ACCESS. Preintegration testing is usually performed well in advance of final delivery, early enough to allow time to make any modifications, if necessary.
It is expected that, prior to customer hardware delivery to GSFC, the experiment will be fully tested and qualified for flight at the customer's facility. This includes any environmental (e.g., vibration, thermal vacuum, electromagnetic compatibility) testing required.

Note: As an optional service GSFC could perform customer analyses and T&E.

### 3.6.2 GSFC Integration and Test

Upon final delivery for preflight integration, approximately eight months prior to launch, the customer performs a post-ship stand-alone functional test. This is usually conducted in a class 100,000 cleanroom facility which supports HH integration. Throughout preflight operations, the customer's flight hardware may be accommodated with optional services, such as a dry nitrogen purge.

Integration of the experiment with the HH carrier begins with mechanical integration of flight components, either into a canister or onto a plate or pallet. All experiment hardware is then electrically integrated with the HH avionics, which includes continuity and isolation resistance checks. After all electrical connections are made, functional tests are performed with the HH, ACCESS, and CGSE. Finally, thermal blankets are installed, as required.

Once all experiments and payload components are integrated, the entire payload is moved to the electromagnetic compatibility (EMC) test facility. An EMC test is performed to the requirements specified in the Shuttle "core" Interface Control Document, ICD-2-19001. Usually at this time, telemetry is also recorded for later use during mission simulations.

The configuration of all Hitchhiker carrier hardware and software is controlled via the SSPP configuration management process. Since GSFC has no control over customer hardware or software configuration, the SSPP has instituted a process by which changes to customer hardware or software can have greater visibility and review for potential impacts. Upon hardware delivery to GSFC, customers are requested to complete and submit a "Customer Configuration Change Request" (Figure 3.5) for any changes to hardware or software from that originally approved for use.

### 3.6.3 KSC Prelaunch Operations

Following the EMC test, the payload and GSE are shipped via an environmentally controlled vehicle to the KSC launch site. Following arrival at KSC, the payload is transferred into a Payload Processing Facility (PPF), typically a class 100,000 cleanroom facility. The payload is then functionally tested and prepared for Orbiter integration. This includes short functional tests of each experiment using the CGSE and the ACCESS.

After all electrical operations are complete, the payload is typically transferred to the orbiter integration facility via KSC's transport canister (for bridge payloads) or by van (for side-mounted payload.) Orbiter integration is accomplished either horizontally in the OPF or vertically at the pad, depending on schedule and on access required for integration (Figure 3.6).

Following Orbiter electrical connections, an Interface Verification Test (IVT) is performed with the payload. The purpose of this test is to perform the minimum testing required to verify copper path interfaces between the payload and the Orbiter, and is not considered a functional test. During the IVT, HH is controlled by KSC from the Launch Control Center (LCC) and monitored by HH and customer personnel at the PPF.

After the IVT and prior to payload-bay door closure, close-out operations are performed. These include removing any purge or trickle-charge lines, removing any non-flight covers, and taking payload close-out photographs.

### 3.6.4 Postlanding Operations

Following the mission, nominal landing is at KSC. The payload is deintegrated from the Orbiter at the OPF and is typically transferred via transport canister or van to the PPF. Usually, no post-flight testing or experiement deintegration is conducted at KSC.

The payload is then shipped back to GSFC for carrier and experiment deintegration, at which time the hardware is returned to the customer. This occurs approximately one month after a landing at KSC. Contingency post-flight testing may also be performed at GSFC if necessary.

| CUSTOMER CONFIGURATION CHANGE REQUEST (CCCR) | | | | | |
|---|---|---|---|---|---|
| TITLE | | | | DATE | CCCR NO. (GSFC use only) |
| ORIGINATOR | ORG. | PHONE | EMAIL | PAYLOAD/EXPERIMENT | |
| REASON FOR CHANGE ☐ Improvement ☐ Reliability ☐ Test Failure ☐ Specification ☐ Other ____________ | | | | RETEST REQUIRED ☐ No ☐ Yes (see below) | |
| AFFECTED FLIGHT SYSTEMS ☐ Experiment/Instrument ☐ Structures & Mechanical ☐ Electrical & Cables ☐ Other ____________ | | AFFECTED GROUND SYSTEMS ☐ Customer GSE (CGSE) ☐ Customer Electrical GSE & Cables ☐ Customer Mechanical GSE ☐ Other ____________ | | TYPE OF CHANGE ☐ Hardware ☐ Firmware ☐ Software | |
| DRAWINGS AFFECTED | | | EST. START DATE | EST. CLOSE DATE | |
| PROPOSED CHANGE | | | | | |
| RATIONALE<br><br>(attach additional information as required) | | | | | |
| RETEST PLAN | | | | | |
| PASS/FAIL CRITERIA<br><br>(attach additional information as required) | | | | | |
| COMMENTS | | | | | |
| APPROVAL:<br>____________ I&T Manager ____________ Date<br>CLOSURE:<br>____________ Customer Representative ____________ Date | | | | | |

FIGURE 3.5 CUSTOMER CONFIGURATION CHANGE REQUEST (CCCR)

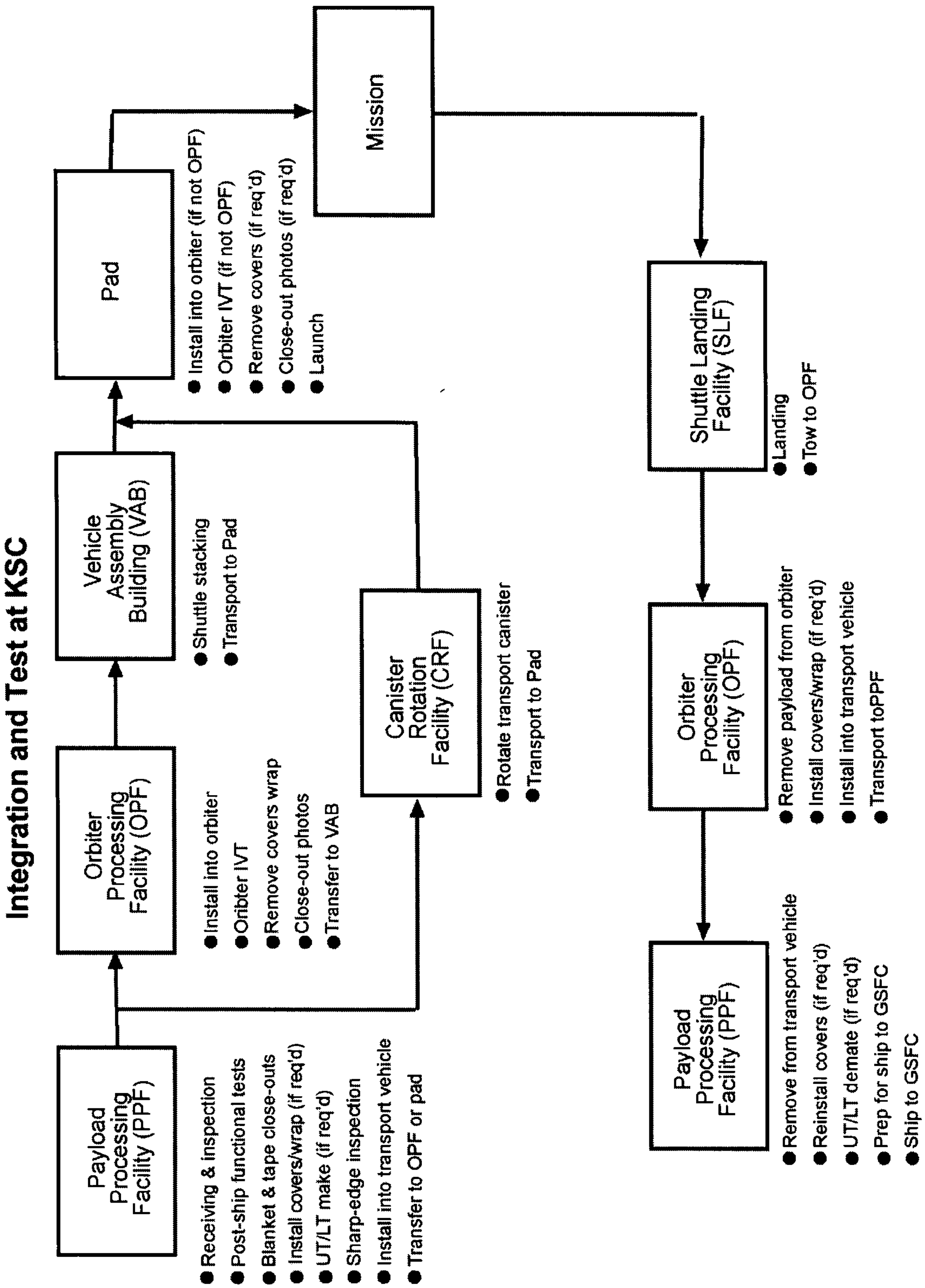



FIGURE 3.6 INTEGRATION AND TEST AT KSC

## 3.7 Mission Planning Overview

The mission operations planning process, as shown in Figure 3.8, is concentrated about the generation of documentation at JSC and GSFC describing HH customer requirements and mission objectives. Operations documentation that is required for a HH mission, as shown in Figure 3.9, includes both joint (between JSC and all payloads) and HH specific documentation. Documents are developed as required for the joint operations and the JSC is supported in the final preparation of these documents. HH specific documents are developed which define operations to be followed by the HH team that are integrated with the JSC operation documents. Operations meetings that are required for a HH mission are shown in Figure 3.10. The following describes the mission operations planning process.

## Customer Deliverables

Most of the documents listed here are also in NSTS 13830, where additional data submittal requirements are listed. These documents are the ones most thoroughly reviewed and discussed with experiment organizations and generally require the most resources to produce. The due dates listed refer to submittal of your experiment safety data packages (SDP) to Goddard.

Due at Phase 1 Submittal

1 Fracture Control Plan per NASA-STD-5003

2 Proposed plan for structural design and verification (per NSTS 14046, including Beryllium, glass, and composite/bonded structures)

3 List of pyrotechnic devices and functions performed

Due at Phase 2 Submittal

1 Fracture Control Plan Update/Status per NASA-STD-5003

2 Structural Verification Plan per NSTS 14046 including:
- (a) Summary of design loads derivation leading to critical load cases
- (b) Math model verification plan
- (c) Pressurized system qualification and acceptance test plan

3 Data for pyrotechnic devices including:
- (a) Inspection plans for critical components
- (b) Qualification and acceptance plans (include demonstration of functional margin)

Due ONE MONTH PRIOR TO Phase 3 Submittal

1 Structural Verification Report including
- (a) Complete stress & fracture analysis for Goddard assessment
- (b) Verification test reports or status report of verification testing

2 Mechanical Drawings with sufficient detail to:
- (a) Verify and assess experiment's interface to HH
- (b) Review and assess experiment stress & fracture analysis

Due at Phase 3 Submittal

1 Summary of results of verification tests/analyses (part of SDP)

2 Fracture Control Summary per NASA-STD-5003

3 Summary of verification tests/analyses results for pyrotechnic devices

Due one month prior to arrival at GSFC

Integration procedures for use at GSFC (if applicable)

Due one month prior to arrival at KSC

Integration procedures for use at KSC, incl contingency procedures

# Hitchhiker Experiment Major Milestones Template

| Discipline | Deliverable Due to Hitchhiker Project |
|---|---|
| Customer Payload Requirements (CPR) Document | 1628 approv. + 1 mo. |
| Public Affairs Office (PAO) Summary and Line Art | Launch – 6 mo |
| Crew Familiarization Briefing Slides | Launch – 6 mo |
| **Mechanical:** | |
| Fracture Control Plan | Ph. 0/1 (L-26 mo) |
| Fracture Control Plan Update | Ph. 2 (L- 18 mo) |
| Structural Verification Plan | Ph. 2 (L-18 mo) |
| Mechanical Drawings | Ph. 2 (L-18 mo) |
| Fracture Control Summary | Ph. 3 (L-6 mo) |
| Structural Verification Report | Ph.3 (L-6 mo) |
| Integration Procedures For Use at GSFC (if applicable) | GSFC deliv. – 1 mo |
| Integration Procedures for KSC; incl. Contingency | KSC deliv. – 3 mo |
| **Electrical:** | |
| Schematics | Ph.2 (L-18mo) |
| Test procedures for use at GSFC | Experiment deliv. At GSFC – 1 mo |
| EMC Test Report, if available | Experiment deliv. To GSFC |
| Command Bit Patterns for Orbiter IVT | Launch – 17 mo |
| Power/current required for standby, nominal, fully operating modes: | |
| Preliminary | Launch – 17 mo |
| Actuals | Launch – 7 mo |
| Test Procedures for KSC, incl. Contingency | KSC deliv. – 3 mo |

FIGURE 3.7 MILESTONE SCHEDULE FOR TYPICAL HITCHHIKER PAYLOADS

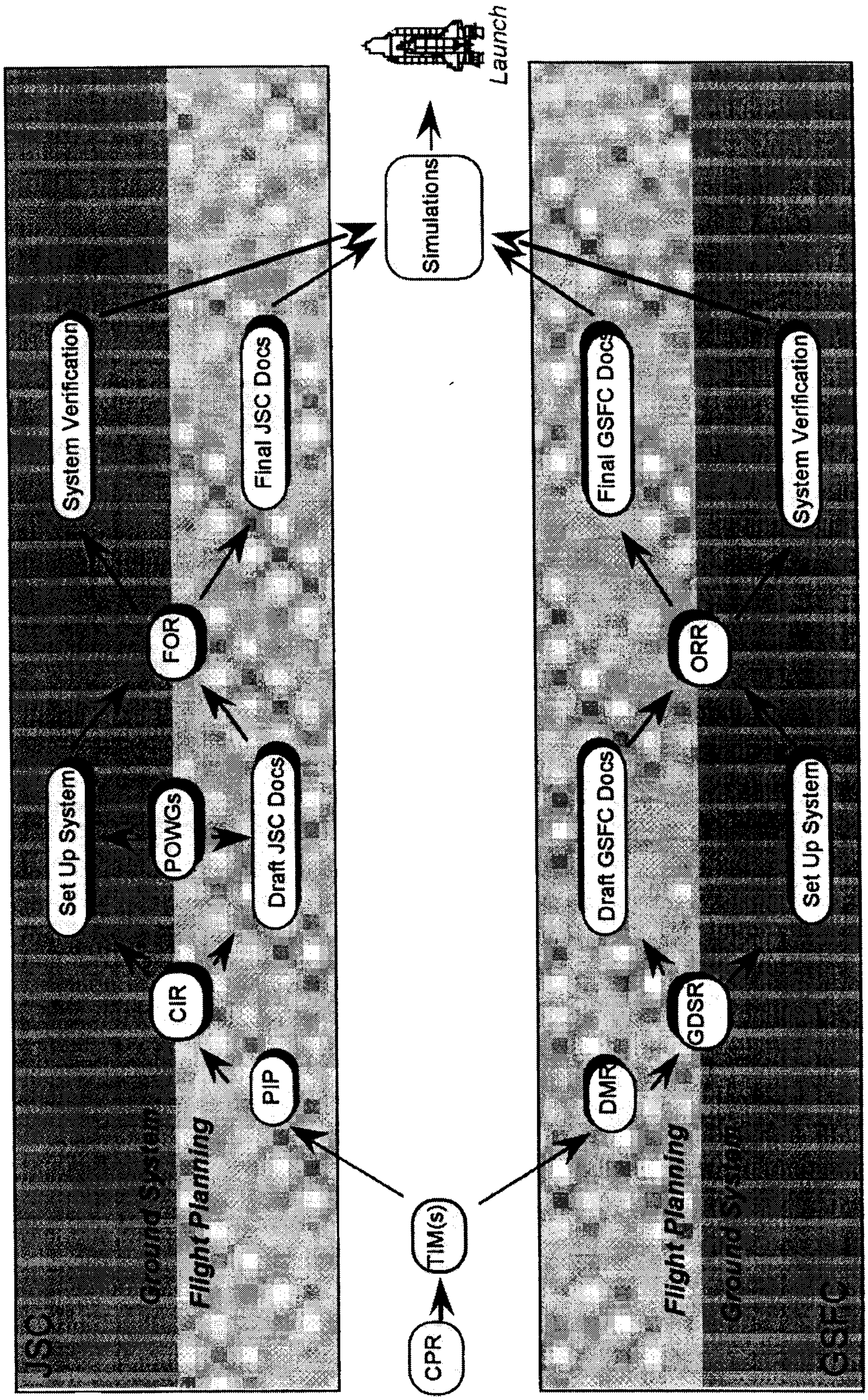



FIGURE 3.8 MISSION OPERATIONS PLANNING PROCESS

### 3.7.1 JSC Documentation and Meetings

The HH mission operations planning process begins with customer submittal of the CPR document (Appendix E) to the HH Project Mission Manager (MM). The HH MM is responsible for the overall integration of the customer's experiment with the HH and Orbiter communities. The CPR is the agreement between the HH Project and the customer which defines the customer's overall requirements for their payload, including mission operations. Much of the information contained in the CPR, descriptive material and mission objectives, will be used in development of operations related documentation required by the JSC and GSFC.

Utilizing the information in the CPR, the HH MM prepares the Payload Integration Plan (PIP) and its annexes. The PIP is the contract between the HH Project, on behalf of the customer, and the SSP. General mission operations information, relating only to those requirements that affect the manifesting of the HH payload with other payloads, is contained within the PIP. Specific mission operations requirements between the HH program and the JSC SSP are defined in the PIP annexes. The customer requirements detailed in the PIP and its annexes are used to develop a basic version of all of the flight documentation products, including the Flight Data File (FDF), used for training and execution of the flight. The FDF is the total on-board complement of documentation and related aids available to the crew for execution of the flight. This includes the Flight Plan (FP), crew checklists and procedures, and reference data. Various other documentation will be developed to coordinate ground operations.

Payload Operations Working Group (POWG) meetings are used to review the customer requirements and to resolve any issues during the development process. The compatibility of the manifested payloads as well as the capabilities of the SSP to meet payload requirements are assessed by the SSP at the Cargo Integration Review (CIR). NASA and the customer review all of the flight documentation at the Flight Operations Review (FOR). Any changes will be reflected in the final set of products, which will be used for the flight.

Approximately six months prior to launch, the HH operations personnel and payload customers will provide a Familiarization Briefing to the JSC payload operations team at JSC. At this time, the JSC personnel are briefed on the HH payload goals and operations.

### 3.7.2 GSFC Documentation and Meetings

Technical Interchange Meetings (TIMs) are the first meetings scheduled by the HH MM to discuss the CPR. At this time, payload integration issues and payload operational requirements and constraints are discussed.

Utilizing the information in the CPR, the Mission Support Manager (MSM) prepares the Detailed Mission Requirements (DMR) document. The requirements detailed in the DMR are used to develop the HH ground system. The draft DMR is presented to the required GSFC elements by the MSM at the System Requirements Review (SRR).

The Mission Readiness Manager (MRM) is then responsible to the MSM to provide the HH ground system based on the DMR requirements. The ground system configuration is reviewed by the MSM, on behalf of the customer, at the System Design Review (SDR). Any changes will be reflected in the final configuration of the ground system, which will be reviewed by the MSM, on behalf of the customer, at the Operational Readiness Review (ORR).

Through consultation with the customer, the MSM determines which GSFC elements and capabilities are required to support the HH mission. The DMR is the contract between the HH Project, on behalf of the customer, and these required GSFC elements. The Mission Operations Working Group (MOWG) meetings are used to develop and coordinate operations procedures at the GSFC. The MRM will coordinate the MOWG process with the required GSFC elements.

The Mission Operations Document (MOD), generated by the MM, provides HH operations personnel with guidelines to ensure an orderly and efficient operations center, preplanned decisions to minimize the response time to anomalous events, and internal operating procedures utilized between the GSFC elements for HH missions.

The customer prepares console procedures to be followed during the mission that parallel the operating cycles defined in the CPR. Procedures also need to be developed to respond to all of the anomalous events outlined in the MOD.

The Hitchhiker Timeline System (HTS) provides operations personnel with communication availability predictions, Orbiter pointing predictions and payload activity timelines. The HTS provides the Attached Shuttle Payload Center (ASPC) with a locally controlled operations timeline as well as with planning information not available from the JSC during a Shuttle flight.

Using the HTS product as a guideline, the customer prepares both detailed and summary experiment command plans to be utilized during training and flight. These command plans will outline experiment command activity during nominal (scheduled) and off-nominal operations periods.

The crew will visit GSFC approximately six months prior to launch for the Crew Briefing. At this time, the crew is briefed on the HH payload goals and operations and views the payload hardware.

| MEETING | CUSTOMER | GSFC | JSC | SCHEDULE |
|---|---|---|---|---|
| Customer Documentation | | | | |
| Customer Payload Requirements | Prepare | Review | | 2 Yrs |
| Console Procedures | Prepare | Review | | 4 Mos |
| Command Plans | Prepare | Review | | 4 Mos |
| GSFC Documentation | | | | |
| DMR (Final) | Review | Prepare | | 12 Mos |
| MOD | Review | Prepare | | 4 Mos |
| HTS | | Prepare | | 4 Mos |
| JSC Documents | | | | |
| PIP | Review | Draft | Baseline | 2 Yrs |
| PIP Annexes | Review | Draft | Baseline | 18 Mos |
| Flight Documentation | Review | Draft | Baseline | 1 Yr |

FIGURE 3.9 HITCHHIKER OPERATIONS DOCUMENTATION SUMMARY

| MEETING | CUSTOMER | GSFC | JSC | SCHEDULE |
|---|---|---|---|---|
| GSFC: | | | | |
| Technical Interchange Meeting (TIM) | Present | Host/Present | | 2 Yrs |
| Systems Requirements Review (SRR) | Optional | Host/Present | | 14 Mos |
| Systems Design Review (SDR) | Optional | Host/Present | | 9 Mos |
| Crew Briefing | Present | Host/Present | Present | 4-6 Mos |
| Operational Readiness Review (ORR) | Optional | Host/Present | | 3 Mos |
| JSC: | | | | |
| Payload Operations Working Group (POWG) | Present | Present | Host/Present | 4-18 Mos |
| Cargo Integration Review | Present | Present | Host/Present | 13 Mos |
| Flight Operation Review | Present | Present | Host/Present | 4 Mos |

FIGURE 3.10 HITCHHIKER OPERATIONS MEETING SUMMARY

## 3.8 *Mission Operations Overview*

The following outlines mission operations and some of the capabilities and limitations with respect to a HH payload.

The HH payload will generally be off throughout the Shuttle powered flight phase and will be turned on after the Orbiter payload bay doors are opened. Therefore, the HH flight operations team will not be able to command or monitor the status of the payload during the launch phase for general missions.

The HH payload will be activated shortly after the opening of the payload bay doors as required for thermal control. The crew will activate the Hitchhiker Carrier (HHC) avionics and enable the HHC main customer power bus by toggling two switches located in the Orbiter Aft Flight Deck (AFD). Activation of the HHC relays to apply power to the HHC heaters, HHC thermal multiplexer, and payload will be accomplished by ground command. Each activation step will be monitored via telemetry.

HH operations will be conducted in realtime based on overall plans prepared premission. The HH payload will be assigned operating periods scheduled according to the requirements of all manifested payloads. Some payloads, such as free-flyer deployments and retrievals, may require dedicated Orbiter support. The assignment of dedicated periods to these payloads will be made based on their priority and large resource requirements including crew-time and power. While higher priority payloads are being supported, the HH may only be assigned sufficient power for activation of payload electronics and thermal conditioning. Low rate data and commanding may only be provided for periodic evaluation of payload health and safety. However, there may be opportunities for the HH payload to operate in parallel with (piggyback) other payload operations. Piggyback operations are background operations, which take advantage of available Orbiter resources and gain science data on a non-interference basis with primary payload activity.

Contingency operations will be supported from the HH ground system using available realtime command capability. In addition, a limited range of contingency support is available from the crew. For instance, the crew provides the capability for disabling of the HHC main customer power bus to turn off a payload in the event that a problem was recognized which could not be corrected from the ground due to a communications problem. Additional relay functions may be used to safe payloads, if necessary, where unplanned Orbiter activities may cause damage.

Prior to closing the Orbiter payload bay doors, the HH payload will be deactivated. The payload and HHC thermal multiplexer will be deactivated by ground command. The HHC customer power bus is disabled by the crew using a switch in the AFD. The crew will then deactivate the HHC avionics using another AFD switch. These operations will be completed shortly before the payload bay doors are closed as required for thermal control.